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A Review of Mining Activities on Land Cover and Land Use Detection Technique in Remote Sensing

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Abstract— Land Use and Land Cover Change (LUCC) can reflect the pattern of human land use in a region, and plays an important role in space soil and water conservation. The study on the change of land use patterns in the world is of great significance to cope with global climate change and sustainable development. This paper reviews the main research progress of LUCC at home and abroad, and suggests that land use change has been shifted from land use planning and management to land use change impact and driving factors. The development of remote sensing technology provides the basis and data for LUCC with dynamic monitoring and quantitative analysis. However, there is no uniform standard for land use classification at present, which brings a lot of inconvenience to the collection and analysis of land cover data. Globeland30 is an important milestone contribution to the study of international LUCC system. More attention should be paid to the accuracy and results contrasting test of land use classification obtained by remote sensing technology.

***Keywords*—**Remote Sensing, Land Use and Land Cover, Mining Activities, Classification

I. INTRODUCTION

In an urban environment natural and human-induced environmental changes are of concern today because of deterioration of environment and human health [1]. The study of land use/land cover (LU/LC) changes is very important to have proper planning and utilization of natural resources and their management [2]. Traditional methods for gathering demographic data, censuses, and analysis of environmental samples are not adequate for multicomplex environmental studies [3], since many problems often presented in environmental issues and great complexity of handling the multidisciplinary data set; we require new technologies like satellite remote sensing and Geographical Information Systems (GISs). These technologies provide data to study and monitor the dynamics of natural resources for environmental management [4]. Remote sensing has become an important tool applicable to developing and understanding the global, physical processes affecting the earth [5]. Recent development in the use of satellite data is to take advantage of increasing amounts of geographical data available in conjunction with GIS to assist in interpretation [6]. GIS is an integrated system of computer hardware and software capable of capturing, storing, retrieving, manipulating, analyzing, and displaying geographically referenced (spatial) information for the purpose of aiding development-oriented management and decision-making processes [7]. Remote sensing and GIS have covered wide range of applications in the fields of agriculture [8], environments [9], and integrated eco-environment assessment [10]. Several researchers have focused on LU/LC studies because of their adverse effects on ecology of the area and vegetation [11–14]. Present study area witnessed rapid development during past decades in terms of urbanization, industrialization, and also population increase substantially. The main objective of this paper is to detect and quantify the LU/LC in an urban area, Tirupati (Figure 1), from 1976 to 2003 using satellite imagery and topographic map.

II. QUARRYING AND MAJOR TYPES OF QUARRYING

A. Quarrying

Quarrying is the surface exploitation and removal of stones or mineral deposits from the earth's crust (Nene, 2011)and it is an excavation of rock to be used for various purposes, including construction, ornamentation, road building or as an industrial raw material. Quarrying activity includes the excavation of rock, gravel or sand from the ground, riverbeds and beaches. Rock-won aggregate is typically produced through drilling and blasting from suitable rock deposits, and crushing and screening to the desired size(Yacoub, 2010). Gravels and sand are normally sourced from riverbeds and from beaches. Excavation typically involves machinery, without the need for blasting. Aggregate products requiring further refinement can often involve additional washing, crushing and screening process.

B. Major Types of Quarrying

RiverDredging: In dredging operations, excavation consists of removal of sediments (soils/overburden) and rocks from the bed of the water body (EBRD,nd). The dredger is used to excavate the materialeither mechanically, hydraulically or by combined action. Sand and gravel deposits are exploited with hydraulic excavators (after removal of top soil) and by dredging below the aquifer level. Depending on the Grain size distribution of the raw material, the extracted sand and gravel may require further classification in order to produce the necessary size fractions for the commercial aggregate products (Chalkiopoulou and Hatzilazaridou, 2011).

Clay Quarrying: A clay pit (brick pit) is a quarry or mine for the extraction of clay, which is generally used for manufacturing pottery, bricks or Portland cement.

Rock quarrying:rock quarries are quarries where rock blocks extracted and rocks are extracted crushed into aggregates. With crusher: for aggregate production (involves stripping, excavation using explosives, processing and trucking)(Yacoub, 2010).

C. Impact of Quarrying Activity on the Environment

Mark and Kudakwashe (2010) in a study in Shurugwi district in Midlands Province of Zimbabwe observed the increase in cropland. He attributed this increase to the Land Reform and Resettlement Program. Large areas of forests were cleared for different farm related activities like opening new farming plots, wood for fuel, poles for building both homes and cattle pens, among other activities. The built-up area around the water bodies in Davangere city, Karnataka, India has almost doubled between 1970 and 2005, at the cost of the agriculture land and scrub land (Begum et al. 2010).

Prakasam (2010) studied land use/land cover change over a period of 40 years in Kodaikanal taluk, Tamil Nadu. In this study major changes has been observed like area under built-up land and harvested land has increased whereas the area under forest and water body has decreased. Javed and Khan (2012) studied land use land cover change during due to mining activities from 2001 to 2010. The study revealed that significant decrease has been observed in dense forest area, cultivated land and water body, however settlement, wasteland land and uncultivated land has increased mainly due to anthropogenic activities.

Our modern times are characterized by large-scale infrastructure developments, which require extraction of large volume of earth materials, of which quarrying is one component. Quarrying operations have economic significance but the effect they cause to the environment could be fatal(Langer, 2001). Such damages include pollution and ecosystem destruction such as damages and permanent changes to nearby landforms, forest and vegetation, natural drainage system, human settlements, etc.

Rock quarrying and stone crushing is a global phenomenon, and has been the cause of concern everywhere in the world, including the advanced countries(Nartey et al., 2012). Quarrying activity is a necessity that provides much of the materials used in traditional hard flooring, such as granite, limestone, marble, sandstone, slate and even just clay to make ceramic tiles. As a result, determining the impact of mining and quarrying activities on the environment is a major challenge in sustainable development and resources management, like many other man-made (anthropogenic) factors(Essalhi et al., 2016).

Quarrying operations generally involve removal of overburden (soil, vegetation), drilling, blasting and crushing of rock materials. The various impacts resulting from these operations are both size and location dependent. Specific impacts could be manifested on air, water, soil, earth surface, flora and fauna, and human beings with variable emphasis(Teeboy Project Report, 2014).

D. Landform Change

Urban areas and their surroundings represent a kind of environment in which the geomorphic effects of human activities are particularly visible. The development of cities, driven by population and economic growth, includes a variety of processes with important geomorphic consequences: concentrated excavation, intensive transport and deposition of materials (often with some transformation), creation of new landforms and environments; as well as triggering of new anthropogeomorphic processes (water accumulation or deposition of different types of waste in excavated areas, instability of new landforms or underground workings, intensified erosion, flooding) that have other environmental implications(Rivas, 2006). Those activities also enhance the effects of natural denudation agents and contribute to sediment supply.

The increase in population has been related to a progressive increase in intensive agriculture, raw material demand and urbanization. As a consequence, human activities are leaving a significant signature on the Earth by altering its morphology. Anthropogenic landscapes cover as great an extent of the Earth's land surface as many other globally important ecosystems. In anthropogenic landscapes, human alteration is reflected by artificial Earth surface features (e.g., artificial channels, road networks, agricultural practices and mining activities) that may affect natural processes(Sofia et al., 2016).

Recent boom in the construction sectors, such as construction of buildings, roads etc., in various parts of the world led to a rise in the number and expansion of size and activities of quarries. These unplanned mining/quarrying activities resulted in environmental degradation including the lowered productivity of the topsoil. Generally the bio-physical effects are associated with the environmental impacts because the fact that many of the quarry sites are uncontrolled and that insufficient techniques of mining are used, it produces a degradation of both land and rock reserves. In many cases there is lack of resource allocation planning in quarry land, a situation that results to quarry sites being located haphazardly without any proper development and guidance. In the end there is a myriad of mineral surface workings that show a lack of resource and environmental management(Ajayi et al., 2015).

The principal geomorphic impact of quarrying is the removal of rocks, which results in the destruction of habitat including relict and active caves and natural sinkholes. The extent of the geomorphic impact is a function of the size of the quarry, the number of quarries and the location of the quarry, especially with respect to the overall landforms. Removal of vast quantity of rocks can change the very shape of the environment. Whole hillsides can be destroyed and layers of valuable soil removed. The influence of quarry size on environmental impact is obvious: all things being equal, the larger the quarry, the larger the geomorphic impacts (Ukpong, 2012).

Surface quarrying technique has serious impact on all landscape components and functions, leading to significant alteration of the original landscape. Once quarrying operations start, the landscape development in progress is disturbed, the original ecosystems are removed, the topography is significantly altered, the basic ecological relations are irreversibly disrupted, and biodiversity is decreased. Quarrying operations can also intensely disturb hydrogeological and hydrological regimes (Zelalem Abate, 2016). Furthermore, fertile soil is dislocated and interrupted and after excavation, pits are left unfilled or abandoned leaving big gaping landscape. This is not only unsightly but poses danger to livestock, wildlife and people as well.

E. Impact on the Water Resources

Commonly the direct impact of quarrying is to remove the overlying vegetation and soil. The removal of topsoil, overburden and aggregates may affect the quality of water recharging an aquifer, and excavation below the water table may lead to de-watering of adjacent watercourses and wells. Quarries can also be a cause for water table alterations, where the quarries go deep enough to affect groundwater aquifers (Ajayi et al., 2015). Formation of ponds at quarry sites is also a common feature in abandoned quarry sites.

If the protective soil cover or unsaturated rock is removed, the hole created by the mining may focus surface water to the groundwater system. As a result, the quantity and physical and chemical quality of surface water and groundwater may be affected and flows can be increased or decreased and may be contaminated by runoff or dust from the quarry(Zelalem Abate, 2016).

The overall impact of quarrying activity on ground and surface water include(Yacoub, 2010):

- Decreasing aquifer recharge and increasing surface water runoff where topsoil is removed leaving bare rock surfaces;
- Disturbing land drainage, and overloading and eroding receiving watercourses, due to greater and faster runoff and uncontrolled pumped discharge of surface water and groundwater;
- Altering the surface over which water flows;
- Changing the pattern of surface water flows;
- Changing the surface and groundwater resources quantity and quality, such as partial blockage of streams due to roads or construction of crushers over or within the right of way of streams and water contamination by particulate matter or by waste material deposited on river banks;
- Increasing the risk of contamination to underlying aquifers due to removal of the natural filter medium; and
- Exposing groundwater to quarry wastes.

F. Impact on Biodiversity

Quarrying carries the potential of destroying habitats and the species they support(Lameed and Ayodele, 2010). Even if the habitats are not directly removed by excavation, they can be indirectly affected and damaged by environmental impacts – such as changes to groundwater or surface water that causes some habitats to dry out or others to become flooded. Even noise pollution can have a significant impact on some species and affect their successful reproduction. Nevertheless, with careful planning and management, it is possible to minimize the effect on biodiversity and in fact, quarries can also provide a good opportunity to create new habitats or to restore existing ones(Tanko, 2007).

G. Impact on the Atmosphere

Dust from quarry sites is a major source of air pollution, although the severity will depend on factors like the local microclimate, the concentration of dust particles in the ambient air, the size of the dust particles and their chemistry, for example limestone quarries produce highly alkaline (and reactive) dusts, whereas coal mines produce acidic dust (Emil, 2010). The air pollution is not only a nuisance (in terms of deposition on surfaces) but it could have serious effects on health, in particular for those with respiratory problems.

H. Social Impact

Social impacts related to the increase in quarrying activities include: threats to health and safety, displacement of communities, damage of cultural sites, and the formation of mining villages(Lad and Samant, 2014).One of the major problems is that while the mining companies pick the biggest share of the benefits from quarrying, the local communities suffer from the negative impacts of these projects. This has led to persistent conflicts between mine owners and the locals living near quarry sites.

Potential impacts of the quarrying activities on health and safety of quarry workers and residents in the nearby areas may result from operation of equipment, circulation of hauling vehicles, use of explosives, propelling of rock fragments, vibration, difficulties in accessing the quarry site, increase in mosquitoes populations and possibly malaria due to the collection of rain water in abandoned quarry depressions, which create good breeding ground for mosquitoes (Yacoub, 2010).

Surface quarrying technique has serious impact on all landscape components and functions, leading to significant alteration of the original landscape. Once quarrying operations start, the landscape development in progress is disturbed, the original ecosystems are removed, the topography is significantly altered, the basic ecological relations are irreversibly disrupted, and biodiversity is decreased. Quarrying operations can also intensely disturb hydrogeological and hydrological regimes (Zelalem Abate, 2016). Furthermore, fertile soil is dislocated and interrupted and after excavation, pits are left unfilled or abandoned leaving big gaping landscape. This is not only unsightly but poses danger to livestock, wildlife and people as well.

Land Use and Land Cover (LULC) are two subjects that have triggered a number of research activities and resulted in a wealth of different approaches to detect past change and also to predict future development (Opeyemi, 2006). Among the most prominent methods are those that use remote sensing and image analysis combined with various statistical and analytical procedures (Arsanjani, 2011).

LULCC identifies all kinds of human alterations of the surface of the earth. Land cover refers to the physical and natural space over the earth surface, including vegetation, water, bare soil and artificial structures (Ellis and Pontius, 2006). Arsanjani, (2011) also considers land use as a complicated expression with different views compared with the term land cover. As such, land managers and social researchers characterize this term generally to include social and economic purposes, while natural science researchers classify the term as different aspects of human activities on land such as farming, forestry and man-made constructions (Ellis and Pontius, 2006).

The study of LULCC through the use of satellite observation has been a major focus of interest to several researchers', right from the early days of aerial photography. However, it has gained momentum with the availability of recent remote sensing techniques that use aircraft and satellites as platforms with the capacity to operate outside the visible part of the electromagnetic spectrum through thermal radiation (Reddy, 2008). For instance, as Ghana strives to attain the status of a developed country in future; expertise in LULCC analysis is needed to curb the emerging problems of chaotic and unregulated development, deteriorating environmental quality, loss of wetlands, fisheries and wildlife habitats. In addition, LULCC data help researchers to assess and understand various environmental practices and problems in order to successfully improve current levels of environment quality (Ikusemoran, 2009). Therefore, this study seeks to use LULCC data to carefully assess changes in land cover of Buoho Township and surrounding communities, which has been caused by quarrying and other human related activities over a 28 year period. Also, the impact of noise generated by the quarrying activities would also be observed to determine the level of blast and other quarry generated noise on the exposed population.

I. Dynamics Land Use Land Cover Change

The environment of Ghana is rapidly changing, with land usage and climate change as the most dynamic components contributing to this trend. These components pose serious challenges to nature conservation and management of endangered zones within the country. Hence, dealing with these challenges require efficient monitoring and management of the environment, backed by expert observation strategies (Manakos and Braun, 2014). There are several driving forces which trigger the extent of change in land cover to meet demands for human sustenance and developmental needs. Meyer and Turner II, (1992) characterized some of the main driving forces of LULCC as socio economic organization, technological capacity, level of development and culture.

Quarrying is a major contributing factor to LULCC, though its importance to the economy of a country cannot to be underestimated. Its role in economic development is crucial in terms of production, employment creation and foreign exchange generation (De Vera, 1996). Tujan and Guzman, (1998) also appraised the economic contributions of mining industry but in contrast to De Vera, (1996); they made a tough critique. Tujan and Guzman, (1998) asserted that similar to other sectors of the economy, mining or quarrying firms are usually co-owned by few wealthy local and foreign investors operated on a small or large scale. Therefore, majority of equipment needed to run the sector are import reliant and the mined commodities also usually export oriented, thus pushing the country into regression and plunder by foreign establishments. In addition, activities of these mining corporations gravely impact on the land cover causing depletion and loss of its aesthetic nature.

Weijers, (2012) notes that population growth is most of the time defined as the primary cause of urban sprawl. Christiansen and Loftsgarden (2011) also consider housing preferences of people and the characteristics of residential areas as major driving factors for urban sprawl. As the city centres get congested with population growth, the peripheral areas with low crime rates and quiet neighbourhoods usually serve as an ideal zone for land seekers and occupants, thus putting enormous pressure on the land space and its use.

III.REMOTE SENSING AND MAPPING SOLUTIONS

In the advent of a rapidly growing global population, acquisition of consistent and reliable data is needed by managers and planners, for effective decision making. The use of factual information plays a pivotal role in several establishments involved in the constant process of decision making for evaluation of different alternatives. For instance, pictures and aerial photography by their nature portray concisely accurate information about spatial locations, sizes and relationships between objects (Campbell and Wynn, 2011).

Remote sensing is referred to as the acquisition of information of an object without necessarily coming into physical contact. Remote sensors gather data through detection of the earth's reflected energy. These sensors are usually on satellites or mounted on aircrafts. The term remote sensing is also limited to objects that reflect irradiated electromagnetic energy excluding electrical, magnetic or gravimetric parameters that measure the force fields between the sensing device and sensed object (Sabins 1978). Campbell and Wynn, (2011) further define remote sensing as using electromagnetic waves in one or more regions of the electromagnetic spectrum through emission or reflection of the earth surface to obtain information about land and water surfaces through acquisition of images from an overhead perspective.

A. Image Interpretation

Producing and interpreting images on a computer monitor or printed sheet have always been a prime concern of researchers. Image interpretation involves examination of raw data and execution of various data rectification and restoration tasks. Afterwards, the rectified data is converted back to images and used in extracting information by visual interpretation or to support digital image classification (Bakker et al., 2009).

Image interpretation or analysis is referred to as the act of evaluating remotely sensed images for the purpose of object identification and assessment of their relevance (Reddy, 2008). These remotely sensed images undergo various forms of logical processes to identify, measure, classify and evaluate the relevance of pattern and spatial relationship between physical and cultural objects. Bradley and O'Sullivan, (2011) also explain image interpretation as the use of band ratios constructed from each input image such as NDVI to determine differences between band ratios at different periods. For instance, in determining the differences between NDVI images, positive output values indicate an increase in vegetation, negative values indicate decrease in vegetation, and values near zero indicate no change. This technique enables change detection of remotely sensed images to be assessed over vast land areas. However, the results may not be as accurate or precise in comparison to those directly acquired from field monitoring.

Karl and Axel, (2013) note that using Global Position System (GPS) to obtain vegetation data, may be spatially more precise or accurate than those acquired through satellite imageries, which has their accuracy or precision limited to the resolution of the pixel. Although, there is a possibility of image pixels being compromised when vegetation types are mixed, there would still be problems with the accuracy since DN values for each pixel would remain single.

B. Change Detection

The influences of environmental, social and economic dynamics cause LULCC to occur at varying rates and in different locations. Molders, (2012) states that these changes in rate can be subtle, gradual, intense, or sudden. The activities of quarrying is a typical example of an environmental dynamic that can cause a sudden change in the earth's landscape, while farming and grazing produce gradual changes. Detection of these changes involve the use of manual interpretation or a remote sensing software such as Erdas Imagine, Idrisi Selva or ArcGIS. Manual interpretation of remotely sensed images or aerial photos is done by defining areas of interest and comparing two or more images of different periods by an observer or expert while digital interpretation involves either an on-screen analysis of two or more images of different periods using GIS software or paper print (Karl and Axel, 2013).

Many change detection algorithms have been used over the years to estimate statistical relationships, principles and assumptions of several remote sensing applications for LULCC evaluation (Singh, 1989). These change detection algorithms include image digitizing, overlay, differencing, regression, rationing, vegetation index differencing, post classification comparison and change vector analysis (Singh, 1989, Coppin and Bauer, 1996, Sunar, 1998). There is no such thing as the best change detection approach, since most of these algorithms have been applied successfully for LULCC analysis. The contributing factors include easy data accessibility, topography of study area, calculating restrictions and type of software application (Kebede, 2009).

C. Manual method

This method of interpretation is employed, when determining changes in images or photos from different sources such as comparison between historic aerial photographs and satellite images. Nonetheless, this traditional method of LULCC detection is time consuming, labour intensive and executed sporadically. In view of these constraints, users have become increasingly reliant on multi-temporal remotely sensed data (Sader and Hayes, 2001).

D. Automated Method

This method involves the use of satellite images or aerial photographs to detect LULCC through the use of a remote sensing software such as Erdas, ArcGIS or Idrisi Selva. This method of automation is in two forms, namely: post classification change detection and image differencing using ratio bands (Karl and Axel, 2013). Post classification analysis involves comparison between two or more classified images that have been categorized into distinct patterns known as land cover types or classes. In the process of comparing the classified images, areas showing the same or different classifications are tallied to produce the final output map. Unclassified areas and erroneous classifications are subsequently removed. Some approaches that are normally used for change detection are NDVI, MSAVI, supervised and unsupervised classifications.

In comparison to the manual method of change detection, the automated approach offer users huge economic gains due to its capacity to assess huge landmasses of interest such as the study area. Additionally, the availability of remotely sensed data also enable easy review and analysis. Hence, the automated method will be used for all the classification process for this study

Table 1.1 Strengths and limitations of different change Detection Techniques

Technique	Technique	Technique
Image Differencing	Simple to implement and interpret	Nature of change not found. Accuracy depends on threshold selection
Vegetation index differencing	Widely applied for both human-induced and natural forest cover change detection	Threshold identification for detection of vegetation changes represents a key issue
Image Ratioing	The effect of different Sun angles, shadows and topography is reduced	Non Gaussian distribution of image makes threshold selection difficult.
Tasseled Cap Transformation	Data redundancy reduced. Scene independent.	Difficult to interpret and label change information
Change Vector Analysis	It offers qualitative information of the direction and intensity of change. CVA are applicable to any number of spectral bands	Not providing concise from–to information. Accuracy depends on the image quality, geometric correction and threshold.
Post Classification Comparison	Provides from-to change results. Normalize the atmospheric, sensor differences	Accuracy depends on the classification accuracy of individual images.
Principal Component Analysis	Useful to identify where changes occurred	Difficult to interpret the result. Knowledge of the study area is essential
Decision Tree Approach	This technique can be applied to any spectral data or GIS data.	Error in training data will produce poor result
Artificial Neural Network	Provide complete from-to change information and also the nature of change.	Requires accurate training and testing classifications
Cluster Approach	Simple & need not require any explicit assumption about the underlying classes.	Labeling change among a matrix of many overlapping classes may be difficult or non informative.

E. Our Future Work

The rapid phase of urbanization and infrastructure development in Krishnagiri Distirct has been observed recently. The unique characteristics of the granite deposits in Krishnagiri and Dharmapuri Districts of Tamilnadu resulted in making the country a global producer of the granite rocks. This led to intensified quarrying activities between Dharmapuri and Krishnagiri. However, this surface mining method, has a potential to impact the environment in a negative way causing loss in vegetation, depletion of natural resources, increases the Temperature, loss of scenic beauty and contamination of surface water resources. To assess the land cover changes caused by granite quarrying activities, remotely sensed data in the form of Landsat images between 2000 and 2017 were used.

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